GCTS is committed to designing accurate testing systems by integrating innovative software engineering with advanced hardware. GCTS systems perform at the highest levels of reliability, providing efficient systems that satisfy customer needs and expectations.

GCTS TESTING SYSTEMS

SSH-100
Simple Shear System

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

- **Dynamic and static simple shear apparatus capable of applying cyclic loads up to 50 Hz**
- **Digital servo control of shear and normal loads or displacements. Also included is servo control of the confining pressure**
- **Pressure chamber with external acrylic cell wall capable of 2,000 kPa lateral confining pressure**
- **25 kN normal & shear load capacity**
- **Lateral support of top cap to minimize rotation compliance. Sliding base mounted on pre-loaded linear bearings.**
- **Optional internal load cell and deformation sensors with overload protection**
- **Software for automatic performance of simple shear tests with real time graphical display**
- **Optional ultrasonic platens & unsaturated testing**

DESCRIPTION

The Simple Shear system has the capability of servo controlling the shear load actuator, the normal load actuator and the cell and back pressure. Any of the system sensors is capable of providing the feedback signal.

The design of the GCTS Simple Shear System is based on our external cell wall triaxial system. The apparatus has a fixed top and a sliding bottom base mounted on special linear bearings. The system also has a stiff internal support to minimize lateral compliance of the top cap. One of the main advantages of the GCTS Simple Shear System is that it does not require a reinforced membrane as lateral support is provided via the confining pressure. This means that consolidation can be done at K values other than Ko.

The system is capable of testing 100 mm (4 in.), 71

mm (2.8 in.), and 50 mm (2 in.) diameter specimens. Because the internal lateral support can be adjusted up or down, various specimen heights can be tested. This means that the system can be used to test either simple shear or triaxial test specimens with heights up to 2.5 times the diameter.

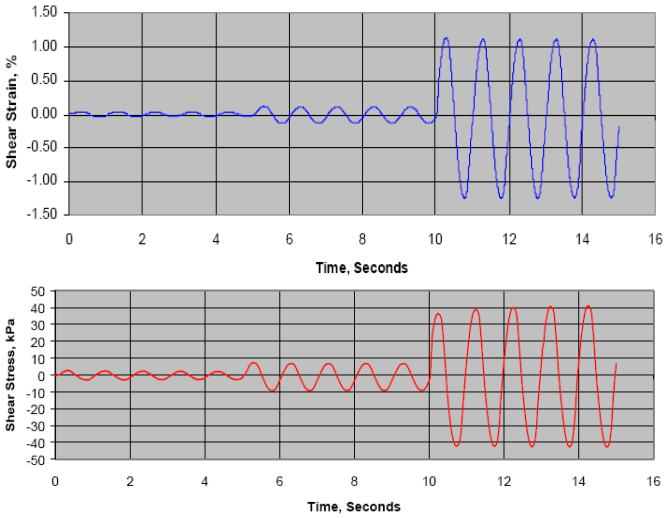
The GCTS Simple Shear System operates inside a pressure chamber that allows applying confining pressures to the specimen. The confining pressure can be servo controlled using the volume change, or any other sensor, as feedback. The servo control of the confining pressure enables the user to perform tests at any K value including Ko with the advantage of directly measuring the value of the K ratio. Reinforced membranes can also be used if desired.

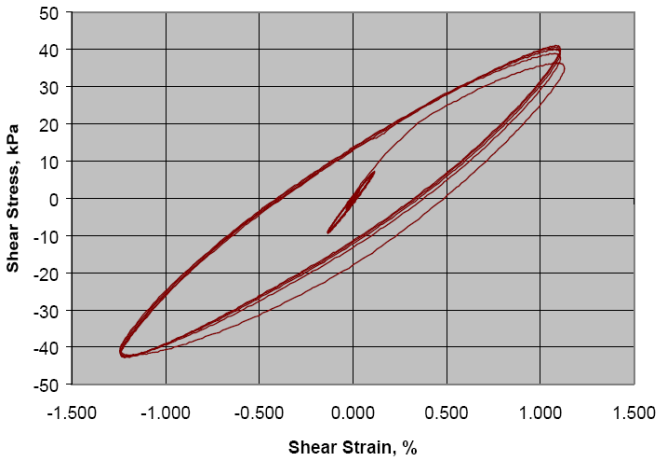
Preloaded Horizontal and Vertical Sliding Supports

The Cyclic Simple Shear Device is designed to achieve the specified loads or displacements at high frequencies. The loading system must be relatively stiff and have sufficient flow capacity to achieve the displacement amplitudes that the specimen is subjected for a given cyclic load. The normal and shear actuators are hydraulically servo controlled providing a very stiff response and loads or deformations can be prescribed. Liquefaction tests on dry sands can be performed by specifying a zero vertical deformation during cyclic shear loads The electro-hydraulic loading system proposed for the normal and shear load actuators is capable of applying or maintaining the prescribed loads with a very small compliance. Hydraulic systems are relatively "stiff" systems as compared to pneumatic loaders because of the incompressibility of oils. In addition, GCTS provides a 16-bit resolution Analog-to-Digital high-speed converter to enhance accuracy.

The last consideration to the control precision is the flow capacity of the hydraulic pump system. The Simple Shear systems is designed with a 10 Horse Power / 20 Liters per Minutes (5 GPM) constant pressure/variable volume hydraulic pump as well as a 2,000 cc (122 cubic inches) accumulator. The standard hydraulic system is more than adequate to meet the required cyclic velocity of ±5% strain at 1 hertz. This requirement is greatly surpassed even for a sample height of 100 mm where the peak-to-peak deformation is 5 mm.

The figures below show sample test data from our Cyclic Simple Shear Test Apparatus. This data was obtained from a cycle test performed by programming a constant normal stress for the vertical actuator and a 1-hertz cyclic shear deformation. The shear deformation was pre-programmed with the amplitude increasing every 5 cycles. A very small shear deformation was programmed for the first 5 cycles, then the amplitude increased 4 times the original amplitude for the following 5 cycles, and finally the amplitude increased 10 times the previous amplitude (40 times the original amplitude). The intention was to obtain the shear modulus and hysteretic damping at very small, medium, and large shear strains within the same test. This test was performed on a 100-mm diameter and 25-mm high specimen. The material was dry sand compacted to a medium density with a constant 100 kPa confining pressure.





The GCTS software includes real-time calculation and control of simple shear test parameters such as shear stress, principal stress direction, octahedral stresses, etc. This type of control makes it very easy to program complex stress or strain paths. In addition, the included adaptive control ensures that the programmed amplitudes are applied precisely even after the specimen undergoes strength reduction such as during liquefaction.

SPECIFICATIONS

1) SSH-100 Simple Shear Testing System
Dynamic and static Simple Shear apparatus capable of applying cyclic loads at up to 20 Hz. Capable of performing isotropic and anisotropic consolidation; UU, CD, and CU tests with volume change or pore pressure measurements; stress/strain path; Ko-consolidation; cyclic loading including cyclic stress path; dynamic shear strength and deformation, liquefaction potential, shear modulus and damping ratio, and other user designed procedures for frequencies at up to 20 Hz. Complete “turn-key” system.

1.1) SSH-100-VF Normal (Vertical) Load Frame
Two column vertical standing assembly with threaded columns for cross-head adjustment and automatic easy loading frame tilt mechanism. Includes the following specifications:

- 50-mm (2 inch) stroke.
- ±25 kN Static load capacity.
- ±20 kN Dynamic load capacity.
- Cast iron rings.
- 50 Hertz maximum frequency.
- 200 mm/sec. maximum velocity
- Manifold including on/high pressure control solenoid and accumulator to minimize pressure ripples.
- High-Frequency Electro-hydraulic servo valve rated to 19 l/min.
- SR-LC-SSM-10k load cell +/-10 kN range. 0.05% precision.
- SR-DF-750-1000 AC Deformation sensor 50 mm range with 0.25% linearity.
- Pneumatic actuator and control valves to tilt frame.
- Maximum vertical daylight opening: 1000 mm.
- Horizontal daylight opening: 430 mm.

1.2) SSH-100-SF 25 kN SHEARL LOADING FRAME
Two column horizontal standing assembly with threaded columns for cross-head adjustment. Includes the following specifications:

- 50-mm (2 inch) stroke.
- +/- 25 kN Static load capacity.
- +/- 20 kN Dynamic load capacity.
- 20 Hertz maximum frequency.
- 200 mm/sec. maximum velocity
- Manifold including on/high pressure control solenoid and accumulator to minimize pressure riples.
- High-Frequency Electro-hydraulic servo valve rated to 19 l/min.
- SR-LC-SSM-10k load cell +/-10 kN range. 0.05% precision.
- SR-DF-750-1000 AC Deformation sensor 50 mm range with 0.25% linearity.

1.3) Pressure Chamber
Four-column stainless steel construction with external acrylic plastic cell wall. 1,000 kPa lateral confining pressure. Includes lines for top and bottom specimen drainage, stainless steel loading pistons, ball bushing guide, and graphite seals. Accepts simple shear and triaxial samples having a diameter of 100 mm and 71 mm. Supplied with valving, fittings, and nylon tubing.

1.4) Test Specimen Accessories.
Set of test specimen accessories and end platens with pore water pressure ports including the following:

- (1) top and bottom 100 mm diameter platens.
- (1) top and bottom 71 mm diameter platens.
- (1) set of porous stones (top/bottom) for 100 mm and 71 mm end platens.
- (12) latex membranes for 100 mm diameter specimens.
- (12) latex membranes for 71 mm diameter specimens.
- (1) Set of O-rings for sealing membranes to platens for 100 mm and 71 mm diameter specimens.

1.5) PCP-200 PRESSURE CONTROL PANEL & VOLUME CHANGE DEVICE
Complete pressure control for triaxial system. Dual use volume change device for triaxial and permeability testing. 150 cc capacity and 0.01 cc resolution. Meets ASTM D3999-91 and D5311-92 pore water pressure measurement compliance requirements. 1,000 kPa pressure capacity. Includes:

- 2 (for cell & back pressure) SR-PR-OM-1000 Pressure Transducer 1,000 kPa range. 0.25% Linearity.
- 1 SR-VC-VAL-DP15-30 Volume change differential Pressure Trans. 500 mm H2O range. 0.25% linearity.
- 3 regulators for manual control of cell, top, and bottom back pressures.
- Precision pressure gage with 2.5 kPa resolution and selector valve.
- Graded water level sight tubes for electronic and manual readings.
- Venturi vacuum pump
- Mounting platform for pressure transducers and necessary plumbing.

NOTE: Requires a 1,000 kPa clean, dry air supply.

1.6) PCP-201 Computer Controlled Cell Pressure
Includes one EP-Valve and required fittings. Maximum pressure: 1000 kPa (150 psi).

1.7) SCON-1500
Microprocessor based digital servo controller, function generator, data acquisition, and digital I/O unit. Advanced servo control from any system sensor with "on-the-fly bump-less" transfer switching between any connected transducer or calculated input. Can be configured to read up to 8 transducers or inputs and control up to 4 outputs.

- 850 MHz micro-processor with 64 MB RAM and 128 MB solid state disk.
- 4 kHz maximum loop rate (100 kHz conversion rate between channels).
- 16-bit resolution.
- Readout for controller internal temperature, pump oil temperature, pump oil level, external temperature.
- 4 digital inputs and 4 digital outputs
- Watchdog timer to detect control program status for automatic interlock shutdown.
- TCP/IP and RS-232 Communications.
- SIGNAL CONDITIONING mother board with 8 Universal signal

conditioning module slots. Accepts up to 8 DSB-111 boards or 8 DSB-113 boards, or any combination of DSB-111 and DSB-113 output boards.
- OUTPUT mother board with 4 output module slots. Accepts up to 4 DSB-12X series boards in any combination of DSB-121, DSB-122, DSB-123, and DSB-124 output boards.

1.8) WIN-CATS-ADV
32-bit Windows 98/2000/NT/XP software for advanced digital servo control from any system sensor or calculated channel with "on-the-fly" bump-less transfer. Includes calculated channels for stress, strain, etc. and user defined equations.
- Third degree polynomial conversions from sensor output in real time.
- Ability to define user defined inputs as a function of other inputs and correct by another input via a third degree polynomial to view or control in real time.
- Configurable unit library to automatically perform unit conversions.
- Linear, log, and semi-log plotting capability with user specified plot parameters.
- Unlimited user configurable view tools (meters, gages, bars, etc.)
- Signal analysis option that will give FFT of any system signal.
- Advanced PID control with adaptive control.
- Peak/Valley compensation on system control.
- Stabilization by any associated input in control, not only the feedback control sensor.
- User defined procedures with up to 100 stages.
- Timed, Level Crossing, and Peak/Valley data acquisition modes.
- Independent and simultaneous synchronized control of up to 16 channels of digital servo control (Close or Open loop).
- Automatic "smooth or bump-less" control transfer from/to any sensor or calculated channel.
- Automated test procedures.
- Waveform library including Ramp, Ramp + Dwell, Sine, Haversine, Triangular, Square, Random, and User Defined.
- Frequency and amplitude sweeping.
- Allows creation of an unlimited variety of waveforms including user-generated profiles such as a digitized earthquake record.
- Easily created cyclic and static customized test procedures.

1.9) WIN-SSH
Simple Shear test software module. Includes static and dynamic test control with automatic stages for Saturation, Consolidation, and Shear loading as well as other advanced tests such as multi-stage stress/strain path, Ko-consolidation, liquefaction, etc.

1.10) Electro-Hydraulic Pump System.
11 LPM, 5 HP, 21 MPa variable volume constant pressure pump. 100 liter reservoir, oil temperature indicator, filter, pressure gage, valves, thermal and low fluid level shut off protection, heat exchanger, hydraulic hoses, accumulator, filler strainer, drain port and motor starter. Includes computer on/off controls. Voltage: 208, 230, 380 or 460 V / 50 or 60 Hz / 3 phase (please specify electrical power at time of ordering).

1.11) Computer System
IBM-PC compatible computer and software to control and execute the test automatically.

OPTIONS

1) SSH-100-UHS UPGRADTE TO HIGH LATERAL STIFFNESS OF SSH-100
Stiffener of the vertical loading piston to reduce the rocking of the top specimen cap. Includes four stainless steel, high-speed, low-friction preloaded carriages with front and back SS rails and adjusting set screws.

2) Internal Instrumentation for Small Strains
- ±1.25 mm LVDT for shear displacement with over travel protection
- ±1,000 N load cell for shear load.
- ±6 mm LVDT for normal deformation
- Signal Conditioning for above transducers
- (5) Feed-through connectors

3) Circumferential Measurement Device
For the measurement & control of radial strains inside the triaxial cell. 2,000 kPa water service. includes Circumferential gauge assembly to measure average radial strain. Includes integrated submersible proximitor sensor with 5 mm range. Accommodates specimens with an initial diameter from 35 mm to 75 mm.
* Note: It is recommended to purchase a deformation calibrator as proximitors require periodical calibration.

4) SCON-1500 UPGRADE
Upgrade of SCON-1500 to SCON-2000 Digital Servo Controller And Acquisition System with the following characteristics:
- 850 MHz micro-processor with 64 MB RAM and 128 MB solid state disk.
- 6 kHz maximum loop rate (250 kHz conversion rate between channels).
- Sample & Hold to eliminate data skew.
- 16-bit resolution.
- Accepts up to 24 DSB-111 Universal Signal Conditioning boards.
- Accepts up to 8 DSB-12X series boards in any combination of DSB-121, DSB-122, DSB-123, and DSB-124 servo output boards.
- Readout for controller internal temperature, pump oil temperature, pump oil level, & external temperature.
- 8 digital inputs and 8 digital outputs
- 48-bit digital counter.
- Watchdog timer to detect control program status for automatic interlock shutdown.
- TCP/IP and RS-232 Communications.

5) Triaxial Accessories to perform conventional Static/Dynamic Triaxial Tests
Set of triaxial test specimen accessories and end platens with top and bottom pore water pressure ports including the following:
- (1) Top and bottom 100 mm platen.
- Spherical seat loading connection set.
- (1) rigid loading connection for stress reversal.
- (1) set of porous stones (top/bottom) for 100 mm end platens.
- (1) forming mold/jacket stretcher for 100 mm specimens with a height of 2.0 to 2.25 times the diameter.
- (12) latex membranes for 100 mm diameter triaxial specimens.
- (2) set of O-rings for sealing membranes to platens for 100 mm specimens.
- WIN-TRX-ADV Triaxial test module to automatically perform unconfined compression and conventional static triaxial shear tests (UU, CU, and CD) as well as other advanced tests such as Stress-Path, Ko-consolidation, etc.